C. MTIS Target Deployment

The MTIS will be capable of providing automated feeds of traffic, transit, and other transportation-related information to the appropriate distribution channels. Basic information may be made available directly to communications outlets; such as Highway Advisory Radio (HAR), while specialized feeds to users will be provided by private sector information service providers. The type and volume of information can be tailored to the user population, the type of distribution media that is employed, and the user's special devices (e.g., pagers, radios, telephone, in-vehicle navigation devices, etc.) for receiving and displaying that information. A key capability within the MTIS will be the automated handling of real-time traffic and transit information, to reduce delays in disseminating critical traveler information to the end user. The MTIS or its derivative (ISP) services will also support the collection and dissemination of real-time link travel time data, whereby vehicles equipped with navigation and route guidance equipment will report link travel time to the MTIS (using Cellular Digital Packet Data (CDPD) or other mobile data communications services) and in turn the MTIS will broadcast this information to all equipped cars via a wide-area broadcast system such as an FM Subcarrier channel. Provision of real-time traffic information will require automated input and processing of data from the various traffic surveillance systems, as well as relevant information collected from manual sources such as cellular phone call-ins and reports from police and roadway maintenance activities.

The MTIS will also support inter-jurisdictional coordination involving activities such as incident response, special traffic control, or vehicle rerouting actions that impact large segments of the metropolitan area (i.e., HAZMAT incident response, special events, weather-related or maintenance operations, etc.) Managers of the traffic network, as well as the organizations responsible for incident/emergency response and maintenance, will be able to share data and more efficiently coordinate plans, assisted by common access to the information within the MTIS databases.

Information distribution channels will include telephone, TV, Kiosks, radio (standard AM/FM and specialized subcarrier), HAR/AHAR, etc. as implemented by private or public sector information and service providers. The MTIS will provide/support a level of data integration (fusion) to clearly reflect the status of the road network (travel times, environmental conditions, special events or conditions, etc.) and transit schedule information. In more advanced systems, real-time traffic modeling capability will permit the near-term projection of traffic conditions in response to incidents and/or special traffic control activities.

D. Projects and Activities Related to MTIS Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- TravInfo,
- TransCal,
- Swift,
- Minnesota Guidestar Projects,
- Atlanta OPTEST,
- Houston Intelligent Transportation System (HITS) including the Houston Transportation and Emergency Management Center,
- Montgomery County Traffic Management Center, Montgomery County, Maryland.

4. Traffic Signal Control System

A. Traffic Signal Control System Description

Current state-of-the-art traffic signal control systems have the capability to dynamically modify the signal timings in response to changing traffic demand and to coordinate operation between adjacent signals to maximize the roadway (network) throughput. Coordination of adjacent signals allows the traffic manager to establish green wave timing, in which vehicles can move through selected portions of the traffic network with less delay. At a minimum, these coordinated signal control systems can provide for the selection of several time-of-day or special signal timing patterns that can optimize operations along major arterial routes and over traffic networks. The capability to adjust the traffic signal timing includes computer-generated timing plans and supports manual operation by a skilled and knowledgeable operator when required. The "open architecture" hardware/software systems are designed to be upgraded in capability, enabling relatively inexpensive installation of improved products. This open architecture approach also supports the potential extension and integration of capabilities, such as the coordinated operations with adjacent freeway and arterial systems.

To be effective, advanced signal control systems require an accurate current picture of the traffic loading and status on the traffic network. This information will consist of real-time inputs from traffic sensors (magnetic loops, video cameras, etc.), status and incident reports from police and cellular call-ins, etc. Historical demand information, such as time-of-day specific data, would at a minimum, permit the establishment of separate time-of-day signal control strategies.

The various jurisdictional systems should be capable of electronically sharing traffic flow information with the signal systems of adjoining jurisdictions in order to provide metropolitan-wide signal coordination. This information sharing supports coordination of traffic signal systems along major corridors, and results in smooth traffic flows across jurisdictional boundaries.

B. Signal Control Systems Benefits

Traffic flows will be smoothed by the use of coordinated traffic signals on major arterials. Overall network efficiency and throughput can be increased dramatically by these traffic control techniques. Emergency response can also be expedited through centralized, coordinated control of the signals. Signal preemption may also be used in selected situations to improve transit system performance, by extending green cycles to permit transit vehicles to maintain their schedules.

C. Signal Control Systems Target Deployment

Advanced capabilities are characterized by the deployment of adaptive/predictive traffic management systems that can quickly react to new traffic situations and implement new signal timing plans based upon a current view of roadway and traffic conditions as well as the predicted conditions expected under the new signal timing plan in a 30-60 minute period.

Advanced traffic/network simulation models and signal control algorithms combined with more complete and accurate surveillance data will allow the traffic manager to react to incidents and other traffic flow anomalies quickly and appropriately. Traffic signal control, in this time-frame, involves the integration of advanced surveillance systems with control and short-term forecasting algorithms and support systems that will facilitate traffic management functions. The traffic manager will be supported by data fusion algorithms combining surveillance data from various sources, with historical (time-of-day) information to present a clear picture of the current roadway and traffic situation. In conjunction with the facilities of the MTIS, the target deployment of signal control systems will establish the mechanisms for regional coordination of traffic management functions among adjacent jurisdictions and will facilitate incident/special event management and response.

The traffic management capabilities will be modular to permit enhancement and evolutionary growth without the need to do major system replacements as new technologies and system-level capabilities are developed. Traffic signal control will also be modular and flexible so that real-time control strategies could be implemented selectively for any portion of the traffic network, as required by the conditions being experienced on roadway.

D. Projects and Activities Related to Signal Control System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- FASTRAC-Oakland County, MI,
- Houston Transportation & Emergency Management Center (TEMC),
- Santa Monica, CA,
- Montgomery County, MD.

5. Freeway Management System (FMS)

A. FMS Description.

Freeway traffic managers in a metropolitan area have the capability to:

- monitor traffic and other environmental conditions on the freeway system,
- identify recurring and non-recurring flow impediments,
- implement various control and management strategies (such as ramp metering and/or lane control, or traffic diversion),
- provide critical information to travelers through infrastructure-based dissemination methods, such as variable message signs and highway advisory radio.

Methods for monitoring freeway conditions include magnetic loop (speed) detectors, video cameras (with and without signal processing capability), and microwave radar and ultrasonic speed monitors. Other sources of information on the freeway include the traditional inputs from police and maintenance personnel as well as the increasing number of cellular phone reports from drivers. As discussed later, relevant information will also be available to support incident management and congestion mitigation activities on the freeway and to coordinate these actions with adjacent traffic signal control systems. With video coverage of incidents on the freeway, the incident management agency can determine the severity and type of incidents that have occurred and can direct the appropriate resources to the scene. This will permit both faster response and better utilization of the incident/emergency response resources through a tailored response.

The freeway management system(s) include(s) a Freeway Management Center (or multiple centers when responsibility for the freeway system is shared by more than one jurisdiction) and information links to the MTIS and other transportation management and control systems in the metropolitan area. These capabilities can provide or be enhanced to provide for the coordination of emergency response and incident management, and to support the management of special-event situations. Examples of integrated/cooperative management include regular analysis and updating of control and incident response strategies and coordination with other local traffic management systems in the area for handling special events.

B. FMS Benefits

With the use of surveillance capabilities associated with freeway management systems, the freeway manager can improve incident response through rapid detection of problems that are causing congestion. Major safety benefits are also associated with the rapid detection and clearing of congestion-producing incidents on the roadway. During periods when congestion is present on the freeway the use of ramp metering access control will reduce the traffic loading on the freeway and will help to smooth traffic flow, thereby lowering the risk of accidents on the affected segments of the roadway. Another benefit of smoother traffic flow is a decrease in most vehicle emissions relative to the congested roadway condition.

Drivers can also be alerted to the incidents and resulting traffic backups through the use of Variable Message Signs (VMS), HAR, or area-wide traffic information broadcasts. In addition to alerting drivers to problems in the roadway, the traffic broadcasts can also provide information regarding the length of expected delays and possible alternative routes to bypass the problem and minimize congestion on the roadway. To be effective this advisory and routing information must be both timely and accurate. Additional advantages can be demonstrated when management of freeways and adjacent arterials are coordinated to provide alternative routes to drivers experiencing incident-related delays.

C. FMS Target Deployment

An additional source of data on freeway travel times will be available in this period when cars equipped with navigation and route guidance equipment report link travel times to the MTIS. This information will be available to the Freeway Management Center for monitoring the travel (traffic flow) conditions. Also as described under the MTIS target deployment, link travel times based upon up-to-date information will be transmitted to vehicles equipped with route navigation and guidance systems.

D. Projects and Activities Related to FMS Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- San Antonio, Texas, Advanced Traffic Management System (TransGuide),
- Minneapolis, MN,
- Houston Intelligent Transportation System (HITS) Programs, Houston, TX,
- Maryland State Highway Authority- CHART Program.

6. Transit Management System

A. Transit Management Systems Description

Transit fleet management systems for metropolitan areas, include hardware/software components on buses and in dispatching centers, radio communications systems, and operations and maintenance facilities and personnel. Many additional capabilities are being considered, depending upon the specific needs of the jurisdiction's fleet management system. These capabilities include automatic vehicle location, advanced voice and data communications, automatic passenger counting, driver information (voice and visual), vehicle diagnostics, geographic information system databases for schedule management and emergency response, as well as computer aided dispatching.

The advanced vehicle location systems provide reliable bus position information to the dispatcher. The dispatcher with computer assistance can compare the vehicle's actual location with schedule information to track schedule adherence and when necessary take corrective actions to either get the vehicle back on schedule or to dispatch additional resources to cover the route. In addition, any pertinent schedule information would be provided to the MTIS for dissemination in near-real-time to the traveler, either via kiosks or at home or office. Consideration also has been given to in-vehicle display of information on routes and schedules for transit passengers. Other capabilities include in-vehicle sensors to monitor information such as passenger loading, fare collection, vehicle diagnostics, etc., to support efficient management of the transit system. In the event of an emergency, the dispatcher can notify the police or other support services of the situation and direct the responding vehicle(s) to the exact location of the incident.

B. Transit Management System Benefits

Benefits will be derived from the transit system's ability to better adhere to published schedules, and to be able to recover from enroute delays through coordination with a traffic management signal control system. Improved scheduling and schedule maintenance have been credited with yielding substantial staff and equipment cost savings for the implementing jurisdictions. Providing accurate real-time schedule information to travelers will increase their feeling of security and potentially increase ridership. Traveler and transit system security is also increased by the capability of the driver to directly call for help in an emergency and by the transit operator ability to quickly locate the vehicle (using the AVL features) to facilitate police or other types of response.

Obtaining more accurate passenger loading data will permit the transit system manager to better manage resources in the system. Given a more accurate statistical picture of route and vehicle loading will permit the system operator to adjust routes and schedules to optimize service for the ridership. An overall benefit will be obtained from the integrated management of transit resources for the metropolitan area, improving the convenience to the traveler when making multimodal trips. Benefits will also accrue when the mode shift is away from private automobile to transit or other HOV options.

C. Transit Management System Target Deployment

Target deployment will include mature implementation of the currently available position location systems, route and schedule tracking software, and schedule status information dissemination capabilities. More emphasis will be placed upon real-time display of transit schedules and transfer points at kiosks and within transit vehicles. Many of the advanced capabilities will be applied to improve transit system management (including day-to-day operations and maintenance activities).

Other capabilities of the transit system are the use of flexible routing to permit deviations from planned routes for passenger pick up and discharge. These improved services, such as dial-a-ride, are expected to be implemented using AVL systems and computerized dispatching and schedule systems. Another key capability of the advanced transit management system will be to manage and coordinate the activities of a variety of transit (fixed-route and para-transit) and other resources (e.g., ride-share) to provide improved (demand response) service in the metropolitan area. The goal of these activities is to improve the efficiency and safety of the traveler and to make multimodal transportation resources more convenient to the traveler.

Another important aspect of transit management systems is the application of computerized maintenance and repair systems to track and manage routine servicing of transit vehicles and other required repair and maintenance activities. On-board automated diagnostic systems can provide either real-time or daily read-out of vehicle subsystem performance. This information can then be used to schedule special or routine maintenance for the vehicle. This computer-based, maintenance management capability can significantly reduce vehicle down-time and reduce the number of unexpected failures within the fleet, thereby reducing operating costs, improving service, and maintaining customer satisfaction with the transit system.

D. Projects and Activities Related to Transit Management System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- Potomac and Rappahanock Transportation Commission-OmniRide Smart Flexroute Integrated Real-time Enhancement System (SaFIRES).
- Denver, CO, Regional Transportation District (RTD) projects.

7. Incident Management Program

A. Incident Management Program Description

Metropolitan areas currently have programs for quickly identifying and responding to incidents that occur on freeways and major arterials. The objectives are to rapidly respond to incidents with the proper personnel and equipment, to aid accident victims, and to facilitate the rapid clearance of the accident from the roadway. Timely execution of these activities will save lives while minimizing the buildup of queues and reducing the delays and frustrations of the traveling public. In this manner the involved public agencies and individuals can satisfactorily meet their requirements and responsibilities. To accomplish incident management, real-time input from the freeway and arterial surveillance systems and the agencies responsible for managing them is critical. Also, by equipping emergency response vehicles with AVL capabilities, these assets can be more efficiently managed. Assignments of response vehicles to cover reported incidents can be based on vehicle location, when, for instance, they are not at their station, and the routing of these vehicles to the incident scene can be accomplished more effectively, based upon accurate knowledge of current vehicle location. Use of a common regional digital map system by the various traffic and incident management organizations will allow the incident management team to better locate the reported incident, and will facilitate the coordination among the several agencies involved in the incident response.

The various jurisdictions and agencies responsible for operations and enforcement in the metropolitan area work together to develop policies and operating agreements that define specific responsibilities for all aspects of incident management, including detection, verification, response, clearance, scene management, traffic control, and information dissemination. These multi-jurisdictional operating agreements ensure routine cooperation, coordination and communications among all agencies, including enforcement, fire, ambulance, highway traffic control and maintenance, environmental (as well as HAZMAT response teams) and other public agencies. Improved surveillance augmented by rapid and accurate reporting of incidents, allows the rapid dispatch of appropriate equipment and personnel to the incident scene.

B. Incident Management Program Benefits

Benefits will accrue in the safety and travel efficiency areas due to the ability to quickly react to incidents, to provide aid to injured travelers, to more quickly warn other drivers on the affected roadway (this would involve coordination with the freeway and arterial traffic system managers) thereby reducing the potential for additional (secondary) accidents triggered by the congestion on the roadway. Finally the rapid response to incidents will help authorities to more quickly clear the incident from the roadway, minimizing the buildup of queues. A key problem addressed by the incident management system is the rapid and accurate assessment of the situation and the determination of the proper levels and types of equipment and personnel to dispatch to the incident scene. This problem will be mitigated by improved surveillance of the freeways and arterials, including mechanisms for quickly and safely determining the types of materials involved in HAZMAT incidents (e.g., electronic bill-of-lading or placarding with remote readout). In addition, the coordination among the numerous agencies and operations personnel to facilitate this rapid response involves many aspects of the core infrastructure described herein. This integrated view, supporting coordinated planning and actions across the infrastructure elements, is the central aspect of ITS.

C. Incident Management Program Target Deployment

In this period there will be improvements in the tracking of HAZMAT materials on the roadways, as well as improvements in the detection of and response to HAZMAT incidents. Mechanisms, such as electronic placarding, will be implemented to remotely (at a safe distance) determine the contents of a HAZMAT carrier involved in an accident, permitting a more rapid and tailored response to HAZMAT incidents.

Other incident management capabilities will include emergency vehicles equipped with navigation and route guidance equipment, use of common map database systems across all jurisdictions in the metropolitan area, and improved coordination across jurisdictional boundaries, to reduce incident response times. Surveillance coverage of the freeway and arterials will be expanded to provide better detection, classification (precise location, severity, type of vehicles involved, etc.), and response to incidents. As is the case with other core features, the target capabilities are substantially improved through closer integration of the functions performed by the traffic signal control, freeway management, and traffic information center functions, and incident management. Coordinated actions in response to the incident and the provision of real-time warnings and alternate route information will improve safety and will permit drivers to bypass the affected sections of roadway.

D. Projects and Activities Related to Incident Management System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- Maryland CHART Program,
- Minnesota Highway Helper Program,
- Houston Transportation and Emergency Management Center (TEMC).

8. Electronic Fare Payment System

A. Electronic Fare Payment System Description

Electronic fare payment systems will be in operation within metropolitan areas for collection of transit fares, parking lot fees, etc. The systems will include hardware and software for roadside, in-vehicle, and in-station use; and passenger/driver payment cards, which possibly would include financial and card accounting systems. Electronic fare collection eliminates the need for travelers to carry exact fare (change) amounts and facilitates the subsequent implementation of a single fare payment medium for all public transportation services.

The system could include both debit and credit card capabilities, although a card with stored-value capability is considered to be a basic requirement. Manual cash payment would continue to be supported. Where appropriate, the system would facilitate private company participation in programs where the employer subsidizes employee work-related travel on the transit system by directly depositing funds in employees' transit accounts.

B. Electronic Fare Payment Systems Benefits

Electronic fare payment systems will facilitate transit vehicle boarding by eliminating the need for exact change or manual payment. The transit operator will continue to maintain the cash fare system but there would be less expense associated with the collection and counting of receipts. Electronic fare payment systems will make the use of the public transit system more convenient to the traveler and may potentially increase traveler use of the transit system.

Electronic fare payment systems for public transit will also provide the transit manager with information regarding ridership (system usage) which will aid in managing resources (bus routes and schedules).

C. Electronic Fare Payment Systems Target Deployment

Advanced versions of the smart (payment) card will be in wide use, providing a single medium for paying travel-related fares and parking fees. Another potential capability is the advance reservation and payment for parking (or other facilities/services) prior to the start of a trip.

D. Projects and Activities Related to Electronic Fare Payment System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- ▼ Fare media tests in Washington, DC, and Los Angeles area.

9. Electronic Toll Collection (ETC) System

A. Electronic Toll Collection System Description

Electronic payment systems are in operation within or around a number of metropolitan areas (and on segments of rural interstate systems) for automated toll collection. The systems include hardware and software for roadside and in-vehicle use, including payment cards or tags and a communications system between the vehicle and the roadside. Toll payment is processed as the vehicle passes the toll station at a safe speed (ultimately at normal highway speed), thereby decreasing delays and improving system productivity.

The system may include any combination of debit, credit, or stored value toll tag capability. ETC systems can be installed in various configurations, including mainline barrier plazas and systems where tolls are based on entry and exit points. Specific functional components of the system would include automatic vehicle identification, automatic determination of toll amount for differing classes of vehicles, automated enforcement of financial violations and flexibility in financial arrangements (e.g., prepaid debit tag, payment cards).

B. Electronic Toll Collection System Benefits

There are several major benefits derived from electronic toll collection systems, both for the driver using the toll facility and for the facility operator. The driver would experience less delay and inconvenience at the toll collection point, since the transaction would be accomplished at normal highway speeds through an automatic debiting of the toll tag. The facility operator would require fewer manually operated lanes, hence fewer personnel would be required to operate the toll collection facilities. Savings as high as ninety percent of the cost of operating a single lane of a toll collection point (fully staffed vs. ETC technologies), have been reported by the Oklahoma Toll Authority. Additional benefits will be derived in terms of air quality in the areas adjacent to the toll facility, where the long queue build-ups, experienced with manual toll lanes, would be eliminated.

C. Electronic Toll Collection System Target Deployment

A major objective for the deployment of ETC systems is the use of common toll readers and tags, that will work in multiple jurisdictions across the U.S. as well as systems deployed in Canada and Mexico. A further goal of the target deployment systems will be to implement a standardized Vehicle to Roadside Communications (VRC) interface (as called for by the ITS National Architecture Program) that can support additional applications, such as commercial vehicle roadside clearance programs and possible intermodal applications. While no major modifications of the toll tag concept will be required, the ETC systems can also be used to implement demand/congestion pricing programs.

D. Projects and Activities Related to ETC System Deployment

The following is a list of infrastructure upgrade projects, OPTESTS, or corridor related activities which apply state-of-practice and advanced technology in the ATIS/ATMS area. They serve as relevant examples of how advanced technology can be applied to support the ATIS/ATMS applications within the metropolitan areas. Many of these projects include elements from multiple core infrastructure features and thereby serve to amplify the approaches for and benefits of integrating core features within the metropolitan area:

- Illinois DOT ETC System,
- New York State Thruway Authority,
- Houston Toll System,
- Oklahoma Toll System.

Annexes: Examples of Current ATIS/ATMS deployments

These examples are currently being expanded:

A. Maryland Statewide Operations Center (SOC),

B. Montgomery County, Maryland Transportation Management System,

C. San Antonio, Texas Advanced Traffic Management System (TransGuide),

D. Houston Intelligent Transportation System (HITS),

E. Denver RTD AVL/Kiosks,

F. Examples of ATIS Projects (Trilogy, SWIFT, TravInfo, TransCal)
F1 - SWIFT
F2 - TravInfo,

G. Boston Smart Traveler,

H. Houston Toll System,

I. Oklahoma Toll System.

Houston Transportation and Emergency Management Center (TEMC)

The Houston TEMC is planned to be a fully integrated center to conduct transportation and emergency management for the greater Houston area. The center will be responsible for the management of a variety of freeway and arterial systems. Components to be managed by the Center include:

- 300 mile Freeway Management System,
- Freeway and Arterial Street Incident Management,
- Ramp Metering,
- Closed Circuit Television Surveillance (CCTV),
- Changeable Message Signs,
- 105 Mile HOV Lane System,
- Regional Traffic Signal System (2800 Signals),
- Emergency Management Operations for Evacuations and Disasters,
- Other ITS initiatives, such as "Smart Commuter" and Motorist Assistance Program (MAP).

Within the Management Center, both the systems, operations personnel and work functions are integrated across functional and jurisdictional boundaries. The center will integrate agency personnel and responsibilities into a single unit that creates a seamless implementation effort, under one management structure. Significant benefits are anticipated due to this integrated structure which will create an effective environment in terms of responsiveness, elimination of administrative, jurisdictional, and organizational constraints and the pooling of financial, personnel, and equipment resources.

The Command Center building will include a central control operations room, communications room, telephone switch room, briefing and operations room for special events and emergency conditions, and three floors of office space for the staff of the participating agencies.

One major part of the TEMC is the Freeway Management System known as the Computerized Transportation Management System, which will monitor, and in some cases control traffic flows. Plans call for the region to have more than 230 miles of computer managed systems in most major freeway corridors. The computerized Transportation Management System is a collection of technologies that form three separate, but integrated subsystems—main lane freeway traffic management; HOV lane surveillance, communications, and control; and the frontage road signal coordination system. Elements of this system include:

- Vehicle detectors for measuring speed, occupancy, and flow,
- Changeable message signs,
- Highway advisory radio,
- Closed circuit television,
- Ramp metering,
- Intersection signal control,
- Fiber optic communications network, and
- Intermediate and central computers.

This initiative is a cooperative effort between the City of Houston, Harris County, Metropolitan Transit Agency (METRO), and Texas Department of Transportation (TXDOT).

MD Statewide Operations Center

The Maryland State Traffic Control Center is a central part of the Maryland CHART (Chesapeake Highway Advisories Routing Traffic) Program. This program is an advanced traffic management and information program which includes the functions of surveillance and detection, traveler information, incident management, and traffic management. The heart of the CHART program is the Statewide Operations Center (SOC), which is expected to be one of the most advanced and sophisticated statewide command and control centers in the nation. The emphasis is on the integration of highway engineering and maintenance functions, as well as supporting the close coordination of activities with State and local enforcement personnel; through inter-agency agreements and on-site representation.

This system is also capable of distributed command and control operations through several satellite Traffic Operations Centers located in other regional areas of the state. These operations centers can provide localized control during peak traffic periods or major incidents. The architecture provides for a centralized information clearinghouse function within the Statewide Operations Center. Information on the major state roadways will be collected through conventional means as well as many new techniques such as video cameras and fixed radar detectors located along the roadway. Other sources of information will be the traditional call-ins from state police and maintenance organizations, cellular call-ins reporting incidents, and close coordination with private sector traffic information providers. Another key element of this program is a communications resource sharing initiative, in which selected communications companies will be permitted to use State highway right-of-ways to install fiber optic cable and in return will provide the State with telecommunications capacity, which will support, among other things the communications requirements for traffic surveillance and operations . Warnings and advisories are provided to travelers through variable message signs, traveler advisory radio, and other conventional means such as private sector traffic information reports over AM/FM radio.

The SOC provides state-of-the-art communications, information processing, and operator interface (video display, control, and communications) capabilities for situation monitoring, coordination and control, and provides facilities for meetings, briefings, and for disseminating status and advisory information to the public.

Montgomery County, Maryland- Transportation Management System

The Advanced Traffic Management System (ATMS) provides traffic surveillance, real-time control and information capabilities for managing the Montgomery County road network. The county has encouraged and supported inter- and intra-agency coordination as part of their transportation management program. The ATMS provides the tools to implement an effective and comprehensive transportation management program. It emphasizes the sharing of information with multiple agencies, the media, and the public.

The ATMS features an open architecture that allows for new technologies to be added to the system. Some of the major components of the ATMS include;

- Advanced traffic responsive traffic signal control for up to 1500 signals (currently all 600+ traffic signals in the county are under computer control),

- Automated variable message and route guidance sign control. (This is currently under testing in controlled areas during 95/96),

- Video surveillance system capable of accommodating 200 cameras. (currently there are 16 cameras operational, with 60 planned for operation by the end of 1995, with an additional 30-50 planned to be added in each subsequent year),

- Capability to monitor 3000 sampling detectors of various types. (1000 loop detectors are planned for operation during 95/96. Machine vision and other detector technologies currently under test.),

- Time critical Geographic Information System (GIS),

- Automated Transportation Information System to include:
    - Travelers Advisory Radio (TARS),
    - Live transportation broadcasts on cable television's County Cable 55,
    - Direct connection to television broadcast stations,
    - Coordination and information sharing with traffic information services (Metro Traffic and Shadow Traffic)
    - Internet connection (Under development during 1995/96),
    - Telephone based voice recognition transportation information system (development and implementation during 1995/96),
    - Kiosks and information centers (Development and implementation during 1995/96).

- Integrated transit and traffic operations and management. (Testing during 1995, full implementation by end of 1996),

- GPS-based automatic vehicle locating system. (Operational—being enhanced),

- Automated incident detection and management system. (Operational—being enhanced),

- Aerial surveillance program including capability to directly coordinate response with multiple agencies and the capability to transmit "live" video from aircraft to the transportation Management Center. (Operational),

- Automated integration with police/fire computer-aided dispatch system. (operational-1995),

- Automated transportation planning support (Operational—being enhanced).

Montgomery County has constructed a communications system throughout the county to support the communications requirements of the computerized signal system and the ATMS. The system includes twisted pair copper wire plus fiber optic cable. The fiber optic cable uses the Synchronous Optical Network (SONET) standard to support data, voice, and video requirements. The fiber optic network is being implemented to support all government, public schools, and college facilities in the county.

The key to the successful operations of the county's transportation program has been the coordination and cooperation of multiple agencies. These include the police, fire and rescue, environmental, planning, and transportation at the federal, state, and local levels. This coordination is enhanced through the capabilities of the ATMS.

The county has an extensive program to provide critical information to the users of the transportation system. Real-time and accurate information is distributed in a variety of formats, by public agencies, the media, and private information companies. This information is used both by the operators of the system and the users of the system.

Another important aspect of the transportation management system is the integration between transit and traffic management. The count's Transportation Management Center will house both traffic and transit personnel. These personnel will share a central system to more effectively manage transportation. Advanced technologies will monitor the location of the county's RIDE-ON bus fleet using the Global Positioning System (GPS) and can automatically adjust traffic signals on a system-wide basis to provide priority to buses that are behind schedule. Full implementation of this capability on the county's 250 RIDE-ON buses is scheduled to be completed by the end of 1996.

The ATMS is also key to the county's transportation incident management program. Through the system's control, monitoring, and information capabilities, incidents can be quickly detected, responded to, adjusted for, and cleared as safely and effectively as possible. The computerized signal system and the county's aerial surveillance program have proven to be critical tools in managing incidents. Other enhancements in detector (technology) capabilities will further improve incident detection performance.

The county also uses the ATMS capabilities to manage special events to minimize the impacts of road closures and high traffic volumes. The system is used both to aid in the planning and in the managing of special events.

Based on materials provided by Montgomery County, Maryland.

San Antonio, Texas Advanced Traffic Management System (TransGuide)

The Transportation Guidance System (TransGuide) project is the first phase of a major Advanced Traffic Management System program for the San Antonio, Texas, metropolitan area. Construction on this project began in early 1993. The project provides for instrumentation of a total of 26 miles out of 191 miles of metropolitan area freeway, plus construction of the complete Operations Control Center, mainframe computer system, application software, communication switching equipment, and all necessary supporting hardware.

This system is designed to provide transportation and enforcement officials the capability to rapidly (within two minutes) react to accidents and incidents on the freeways. The system provides for comprehensive surveillance, automated incident detection and alarms as well as computer-aided analysis and decision support for the traffic manager. The system is highly integrated to support all processes from surveillance/detection through the analysis and response to an incident.

The goals of the system are as follows:

- Incident detection within two minutes of occurrence,
- Changes to all affected traffic control devices within 15 seconds from identification of an alarm,
- Ability for police officers to dispatch appropriate response from the Operations Control Center,
- Designed in system reliability and expandability,
- Ability to support future ATMS and ITS functional capabilities.

Freeway system components include inductive loop detectors, high resolution color video cameras, variable message signs, and lane control signs. The inductive loop detectors are installed in configurations that will provide information regarding vehicle speed, lane occupancy and traffic volume. The high resolution camera will provide 750 lines of horizontal resolution and remotely controlled zoom capability. Field of view at one-half mile is 20 feet vertical by 30 feet horizontal. The variable message signs permit the display of strings of alphanumeric text, using fiber optic bundles to provide bright, easily read characters. The lane control signals are designed to be visible at a distance of a quarter mile under normal atmospheric conditions. Again fiber optic technology is used to produce bright, clearly legible signs.

A digital communications network is used to transport (full motion) video, data, and voice information from the field equipment to the Operations Control Center. This network utilizes SONET standard communication protocols over a fully redundant single mode fiber optic system. The network employs a number of digital matrix switches, a virtual circuit switch, a communications systems switch and a network management switch, as well as digital loop carriers, video codecs, and multiplexors to provide a flexible and reliable digital transmission system.

The mainframe software system supports event detection, routing, analysis, display, and storage and archiving features of the TransGuide system. The software is an integration of tailored Commercial-Off-The-Shelf (COTS) products and custom code developed for the TransGuide system. The software system is key to the operation of the ATMS, supporting the requirement to quickly identify and respond to incidents on the freeway, and to support the traffic manager, with expert systems analysis of data, display of current information and video, as well as supporting remote control of video cameras and VMS and lane control signals.

The ATMS mainframe is the heart of the TransGuide system. It supports the detection, analysis, display, and storage/archiving of the incident data. It monitors the status and provides control of the field equipment, as well as controlling the configuration of the digital communications network equipment. In addition the system employs a network management system to provide status monitoring of all equipment in the digital communications network. All system alarm points are monitored to permit rapid identification and location of malfunctions.

Seattle Wide-area Information for Travelers (SWIFT)

SWIFT is an Advanced Traveler Information System Operational Test, that was selected for implementation during 1994. The project team consists of the following members:

- Delco Electronics Corporation (General Motors Corp. subsidiary)
- ETAK, Inc.,
- Federal Highway Administration (FHWA),
- International Business Machines (IBM),
- King County Dept. of Metropolitan Services,
- Metro Traffic Control,
- Seiko Communications Systems, Inc.,
- University of Washington,
- Washington State Department of Transportation.

Swift is planned to provide an ATIS capability for the Seattle metropolitan area using a high speed data (FM-Subcarrier radio) system communicating to receiver devices capable of receiving the FM-Subcarrier communications. These devices will receive a variety of traveler information types, including traffic advisories, personal pages, transit locations and schedules, and other relevant information.

The receiver devices being tested are:

- Delco radio receivers,
- IBM portable computers,
- Seiko Message Watch (TM).

The portable computer devices will be capable of receiving a map display of current traffic information, bus positions and schedules, and ride-share information. The other planned devices will not support this capability.

The pertinent SWIFT data will be collected by a variety of organizations and processed (validated, integrated and/or fused and formatted) by the University of Washington. The data types being collected are Freeway loop-sensor information, Ride-share information, Traffic advisories, incidents, scheduled events, etc., Bus locations and schedules, and personal paging messages, as well as Differential GPS data. The processed data will be formatted and placed into message frames, for transmission to the appropriate receiver devices.

The radio transmission system provides a wide-area capability which incorporates forward error correction and multiple transmission of data to increase the probability of correct reception of data. The system has a raw transmission rate of 19,200 bits per second, which after error correction and overhead, provides usable information transmission rates of approximately 8000 bits per second. If multiple transmissions of data are included the final "real" information rate will be further reduced accordingly. Messages will be able to be individually addressed as in current pager systems, or group addressed to a common set of receiver devices.

Plans call for the test to include a total of 700 devices, made up of 500 SEIKO Message Watches (TM), 100 Delco radios, and 100 IBM portable computers. Users will be recruited to participate in the test, according to an evaluation plan developed by the evaluation contractor. A variety of technical performance, institutional, and user acceptance issues will be studied during this OPTEST.

Model Deployment for National CVO Core Infrastructure

Background/Primary Objectives:

In order to achieve success in the ITS/CVO program, the technologies developed must be integrated with the information infrastructure. This paper outlines the selection criteria for platforms to deploy the national Commercial Vehicle Operations (CVO) ITS core infrastructure. Initially, we propose to use two prototype States and then to select about six States in three different regions for model deployment of integrated systems for CVO roadside electronic operations at fixed and mobile sites, and electronic purchase of credentials.

The core infrastructure includes the related technologies and information. The Commercial Vehicle Information System Network (CVISN) will be a nationwide system that would provide all authorized users on-line access primarily to Registration, Fuel Tax and Safety information. Legislation requires that states regulating interstate carriers exchange CVO registration and fuel tax information. Additional legislation requires that safety information on commercial carriers and technology be available at the roadside to help inspectors to determine which carriers (Commercial Vehicles) to inspect. CVISN helps meet these congressional requirements and supports additional requirements from states, FHWA, industry and others.

CVO data is currently exchanged between states and industry, but often not electronically. CVISN would provide **electronic** data interchanges for numerous CVO applications and users. Electronic data interchange should reduce the cost and it will provide customers with timely access to available data, that now takes days, weeks or even months.

CVO Model deployment will include an open information exchange network and system and standards required for all CVO applications. FHWA is working in partnership with ITS America and numerous stakeholders including states, academia, private industry and national organizations to define CVO and the information system. Model deployment will result in the establishment of systems in about six test states at a few fixed and mobile sites. It will also provide for electronic data interchange among state agencies and a national communication infrastructure that can accommodate additional states, users, and technologies as they come on-line.

Participation Criteria

The following criteria are proposed to select about six states for CVO model deployment:

Maturity of State's CVO Core Infrastructure

- The state shall have a significant amount of CVO related public and private information processing and distribution capability:
    - The state should have a roadside electronic screening program in place, being developed, or clearly demonstrate how it can develop a fixed and mobile electronic roadside verification program quickly. This includes the capability to electronically identify vehicles with and without transponders, and to screen for safety credentials and weight.

- The state shall be able to provide real-time data entry of interstate and intrastate safety inspections.

- The state should be able to process electronic requests from carriers for interstate and intrastate credentials (e.g., registrations and fuel permits) currently or with minimal upgrades.

- The state should be able to respond to electronic queries from state, federal and industry for interstate and intrastate registrations currently or with minimal upgrades.

Institutional Integration

- The state should have a history of cooperation and outreach among state agencies, with industry and other States for CVO.

- The state shall have a strong commitment to the integration of information age technology.

- The state shall have a history of working in the CVO area and including initiatives and participation in institutional studies.

- The state shall have a strong commitment to the customer service and strive to serve customer requirements.

- States to be selected must demonstrate leadership, organization, partnerships and resources, including financial, for CVO model deployment and continuation of the project.

- Candidate states shall demonstrate a commitment to work with other states and the Federal government to make CVO a reality.

The Chief executive officers for Registration, Fuel Tax, Highways, Size and Weight, and Enforcement shall demonstrate their commitment and cooperation in a memorandum of agreement (MOA). The MOA should articulate a joint DOT/State commitment to the goals and plans of CVO and CVISN. This MOA may include other public and private partners. It will serve as guidance to the program management, budget planners and technical experts deploying the system and it will ensure common understanding and agreement of key requirements and issues.

States selected will represent various geographic regions. The states in each region should have substantial commercial business and truck volumes between each other to allow for higher levels of information exchange.

The State shall be committed to developing a multi-year CVO business plan within 10 months of being selected and a operational system within one year.

APPENDIX V

Early Deployment Studies (cost in thousands)			
Atlanta, Georgia	$450	Kern County, California	350
Austin, Texas	400	Las Vegas, Nevada	400
Baltimore, Maryland	456	Lexington, Kentucky	200
Birmingham, Alabama	400	Louisville, Kentucky	410
Boston, Massachusetts	360	Memphis, Tennessee	400
Buffalo, New York	400	Nashville, Tennessee	220
Charleston, South Carolina	320	New Castle County, Delaware	400
Charlotte, North Carolina	400	New Haven, Meriden, Connecticut	350
Chicago, Illinois	400	New Orleans, Louisiana	400
Cleveland, Ohio	400	New York City/Northern New Jersey	750
Columbus, Ohio	188	Northern Virginia, Washington, D.C.	400
Dallas, Texas	600	Omaha, Nebraska	400
Dayton/Springfield, Ohio	400	Orange County, California	450
Denver, Colorado	713	Orlando, Florida	400
Des Moines, Iowa	275	Philadelphia, Pennsylvania	400
Detroit, Michigan	400	Phoenix, Arizona	400
El Paso, Texas	336	Pittsburgh, Pennsylvania	400
Fort Worth, Texas	400	Portland, Oregon	400
Grand Rapids, Michigan	400	Providence, Rhode Island	400
Greensboro, North Carolina	150	Raleigh area, North Carolina	250
Greenville, South Carolina	200	Richmond, Virginia	400
Hampton Roads, Virginia	486	Rochester, New York	400
Hartford, Connecticut	400	Sacramento, California	400
I-10, New Orleans/San Antonio	250	Salt Lake City, Utah	400
I-279/376, Pennsylvania Turnpike	300	San Antonio, Texas	397
I-40, Northern Arizona	130	San Diego Border, California	200
I-5, Los Angeles-San Diego	150	San Francisco, California	450
I-5, Seattle-Portland	300	San Juan, Puerto Rico	400
I-5/90, Seattle-Vancouver-Spokane	240	Scranton/Wilkes Barre, Pennsylvania	350
I-70, Denver1	68	Springfield, Massachusetts	350
I-71, Columbus-Cleveland	200	St. Louis, Missouri	280
I-79, Erie-Pittsburgh	300	Syracuse, New York	350
I-94, Portland-Boise	320	Tampa, Florida	80
I-90/94, Milwaukee-Minnesota	240	Tucson, Arizona	400
Garden State Parkway, New Jersey	198	Washington, D.C.	400
Indianapolis, Indiana	400	Washington, D.C. (umbrella)	200
Jacksonville, Florida	400	Westchester Co-White Plains, New York	400
Kansas City, Kansas	400	**TOTAL**	**$26,567**

The above funds reflect Federal contribution only. Each locality is required to provide a minimum 20 percent match to Federal funds.

APPENDIX VI

Priority Corridors					
	Funding by Fiscal Year (FY) (mil)				
Corridor	**FY '93**	**FY '94**	**FY '95**	**Members**	**Accomplishments**
I-95 Northeast	$10.500	$ 1.000	$ 7.500	Members of Coalition: Departments of Transportation in Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, New York City, Pennsylvania, Rhode Island, Vermont, and Virginia. Also members are the Delaware River & Bay Authority, Delaware River Port Authority, Delaware Turnpike Administration, Maine Turnpike Authority, Maryland Transportation Authority, Massachusetts Turnpike Authority, New Jersey Highway Authority, New Jersey Turnpike Authority, New York State Thruway, Pennsylvania Turnpike Commission, Port Authority of New York & New Jersey, and Triborough Bridge & Tunnel Authority.	The Coalition completed development of an initial "Business Plan" in May 1993. Updated in 1995, the Plan is the cornerstone of the Coalition's program management. The Coalition also completed the Strategic Plan in 1995. Current projects include: ■ Creation of an "Information Exchange Network" for communications and coordination purposes throughout the Corridor. ■ Development of incident management procedures and support infrastructure which addresses the needs of the Coalition. ■ Development of a coordinated approach to provision of traveler information; greatly improved holiday traveler advisories and construction information are already up and running. ■ Development of a program for commercial vehicle operations in the Corridor, building upon the existing institutional issues study partly funded by the Department of Transportation. ■ Focus on improved intermodal coordination and efficiency.
Houston, Texas	3.105	2.000	2.250	The Texas Department of Transportation (TxDOT), Houston METRO, the City of Houston, and Harris County. The Corridor is located in Harris County, Texas.	The Houston Smart Commuter project, a real-time traffic and transit information system, is being coordinated with other efforts in the Corridor. These efforts include: ■ Development of a Corridor Program Plan, ■ Evaluation of Astrodome area closed circuit television lease, ■ Automatic vehicle identification for traffic conditions and incident detection, ■ Real time information kiosks, ■ Railroad Grade Crossing Monitoring System, ■ Automatic vehicle location for incident management, ■ On-vehicle navigation/information applications, ■ Environmental Conditions Monitoring Systems, ■ Integrated Corridor Advanced Traffic Management System/ Advanced Traveler Information System.

Priority Corridors					
	Funding by Fiscal Year (FY) (mil)				
Corridor	**FY '93**	**FY '94**	**FY '95**	**Members**	**Accomplishments**
Southern California	3.105	2.000	2.250	Steering Committee: California Department of Transportation (Caltrans) New Technology, Caltrans District 7, Caltrans District 8, Caltrans District 11, Caltrans District 12, Southern California Association of Governments, San Diego Association of Governments, San Bernardino Association of Governments, Orange County Transportation Authority, City of San Diego, California Highway Patrol, and the South Coast Air Quality Management District. The Southern California Corridor lies within the major urbanized and adjacent non-urbanized areas of Ventura, Los Angeles, San Bernardino, Riverside and San Diego Counties and all of Orange County.	Three major efforts operate in the Southern California Priority Corridor: field operational tests, strategic deployment planning, and a major demonstration of an intermodal transportation management and information system, known as the "Showcase."
Midwest Corridor	0.000	.810	4.090	The Technical Committee: Chicago Area Transportation Study, the Illinois Department of Transportation, the Indiana Department of Transportation, Illinois State Toll Highway Authority, Milwaukee County Public Works, Northern Indiana Commuter Transportation District, Northwest Indiana Regional Planning Committee, Regional Transportation Authority, Southeast Wisconsin Regional Planning Committee, Wisconsin Department of Transportation, Argonne National Laboratory, Chicago Transit Authority, City of Chicago Department of Transportation, City of Milwaukee, Marquette University, Metra, Milwaukee County Transit and Pace. The Midwest Corridor is located in Lake, Porter and Laporte counties in Indiana; McHenry, Lake, Kane, Cook, DuPage, and Will counties in Illinois; and Washington, Ozaukee, Waukesha, Milwaukee, Walworth, Racine, and Kenosha in Wisconsin.	The Coalition selected a consultant team that began work in July 1994 to assist with the development of a Corridor Program Plan (CPP). The initial CPP was approved by the Corridor Executive Committee in June 1995. The CPP include 5, 10, and 20 year scenarios for the implementation, management, and evaluation of a multi-state, multi-modal corridor program of projects. The real time acquisition and sharing of information across the corridor, useful to both the multi-modal system operators and travelers, constitute the core projects in the initial CPP.

*Funds listed in the table are matched by a minimum 20 percent state-local-private sector matching share. In addition to the above funds, the Midwest Corridor is preparing to submit a Corridor Program Plan that includes a request for $12.5 million for each of Fiscal Years 1995 and 1996. The I-95 Corridor Fiscal Year 1996 Business Plan includes a request for $12.5 million. The Southern California Priority Corridor has submitted an initial business plan that includes a proposed $44 million Showcase project that is scheduled for completion in 1997.

APPENDIX VII

List of Acronyms

AATC	Advanced Automatic Train Control
ACN	Automated Collision Notification
AHS	Automated Highway System
AIBS	Automated Identification and Billing System
APTS	Advanced Public Transportation Systems
ARPA	Advanced Research Projects Agency
ATIS	Advanced Traveler Information Systems
ATMS	Advanced Traffic Management Systems
AVC	Automatic Vehicle Classification
AVCSS	Advanced Vehicle Control and Safety Systems
AVI	Automatic Vehicle Identification
AVL	Automatic Vehicle Location
BSMS	Bus Service Management System
CAD	Computer-aided Dispatching (system)
CCTV	Closed Circuit Television
CDLIS	Commercial Driver's License Information System
CDPD	Cellular Digital Packet Data
CMS	Changeable Message Sign
CVISN	Commercial Vehicle Information Systems Network
CVO	Commercial Vehicle Operations
DASCAR	Data Acquisition System for Crash Avoidance Research
DOT	Department of Transportation
EMS	Emergency Medical Services
ETC	Electronic Toll Collection
ETTM	Electronic Toll and Traffic Management
FHWA	Federal Highway Administration
FMS	Freeway Management System
FOCAS	Forward Crash Avoidance Systems
FTA	Federal Transit Administration
GIS	Geographic Information Systems
GPS	Global Positioning Systems
HAR/AHAR	Highway Advisory Radio/Advanced HAR
HAZMAT	Hazardous Materials
HELP	Heavy Vehicle Electronic License Plate Program
ICC	Intelligent Cruise Control
IFTA	International Fuel Tax Agreement
IRP	International Registration Plan